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DEPARTMENT OF HOMELAND SECURITY

U. S. COAST GUARD

STATEMENT OF

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ON THE

COMPLIANCE WITH REQUIREMENTS OF THE DEEPWATER CONTRACT

BEFORE THE

COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE

U. S. HOUSE OF REPRESENTATIVES

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Good afternoon Mr. Chairman and distinguished members of the Committee. It is a pleasure to appear before you today to discuss Compliance with Requirements of the Deepwater Contract. I am Debu Ghosh the Executive Officer of the Coast Guard's Asset Project Office (APO) Standard Boats. I am a naval architect with over 33-years of experience specializing in the design of high-speed craft. I have been in the Boat Engineering Branch of the United States Coast Guard for the last 23 years, serving as the Branch Chief for the last 15 years.

I have a Bachelor of Technology degree in Naval Architecture from the Indian Institute of Technology, a Master of Business Administration from Tulane University and a Master of Science degree in National Resource Strategy from the Industrial College of the Armed Forces. I am a full member of the Society of Naval Architects and Marine Engineers and had previously served on the American Bureau of Shipping (ABS) Americas - Small Vessel Committee.

I have been involved with the design of patrol boats since 1977. I have worked on the in-house designs of many Coast Guard boats, including the 47-foot Motor Life Boat, 49-foot Buoy Tender, 120-foot Barge, and 120-foot Heritage Class Patrol Boat. I have participated in all aspects of the acquisition programs for these boats as well as the 110-foot Island Class Patrol Boat, 87-foot Coastal Patrol Boat, 45-foot Response Boat, Medium and have supported the small vessel components of the Deepwater Program; the 123-foot Patrol Boat, the Short Range Prosecutor, the Fast Response Cutter and the Long Range Interceptor.

As the Chief of the Boat Engineering Branch, Equipment Management Division at the Engineering Logistics Center, I assign, direct, coordinate and review the work of an engineering team consisting of eight engineers. I also supervise the Central Engine Overhaul program that is responsible for maintaining a rotable pool of over six hundred diesel engines and reduction gears. In addition to technical support for Deepwater, my naval architecture team has been responsible for overall engineering, maintenance and other non-Deepwater acquisition support for the Coast Guard's fleet of about five hundred standard patrol boats and small cutters, comprising almost two dozen major cutter and boat classes. This support includes technical analyses, changes and modifications, engineering changes, configuration management, maintenance, testing, evaluation, trouble-shooting, and logistics analyses.

The 87-foot Patrol Boat provides the best example of the Boat Engineering Branch's in-depth involvement in the acquisition process during my tenure as Branch Chief. Branch members and I provided acquisition support and advice to the Patrol Boat Replacement Project from the beginning of the project. Before contract award, I supervised development of two notional designs, conducted trade-off studies, both in-house and using contractor support, developed sponsor's requirements, wrote the Request for Proposal, Statement of Work, Proposal Preparations, and Proposal Evaluation Factors, and developed independent government cost estimates. As a technical evaluation team member I developed the technical evaluation plan and evaluated proposals. After contract award, I led a team of engineers and provided technical support to the project resident office by reviewing all deliverables submitted by the contractor, Bollinger Shipyards Ltd. I resolved the structural problems with the mast that failed after the delivery of the first cutter, vibration related structural problems with the skeg, and fuel tank pickup problems.

As a naval architect in the branch, I participated in the technical review of the detail design of the 110-foot Island Class Patrol Boats, which were also built by Bollinger. These patrol boats had severe underwater body panel “dishing” problems that occurred after the delivery. I was a member of the engineering team that solved the problem. Since then the 49 110-foot Island Class Patrol Boats have been in service for close to 20 years with approximately 2 million hours of operation with no significant structural failures.

My branch’s participation in the Integrated Deepwater Systems 123-foot Patrol Boat program began in the spring of 2002 following the contract award to Integrated Coast Guard Systems (ICGS). After identifying our initial concerns with possible longitudinal strength problems, I asked both the contracting officer’s technical representative (COTR) and the Bollinger members of the Technical Management Information Team to award contracts to the Navy’s Combatant Craft Division because of its experience with similar problems that occurred after lengthening the 179-foot Patrol Craft and its earlier involvement with the 110-foot Island Class Patrol Boat. I also suggested that Bollinger consult Vosper Thornycraft because it was the original designer of the Island Class Patrol Boats. I was unable to get support for this. However, as the Deepwater contract was a performance based contract, the contractor was responsible for the success of the design. In addition, the strength calculations submitted by Bollinger showed that the section modulus was more than adequate by about a factor of two. Section modulus is a factor based on the geometry of a section that determines the strength of a beam. The stress in a beam is the bending moment, or load, divided by the section modulus, so the section modulus has to be large enough to ensure the stress is below a level that causes failure. Nonetheless, I advised Bollinger to study this matter more carefully, due to the unusual nature of lengthening a lightweight vessel by adding material aft instead of by adding material midships, which is the normal process. An in depth study of critical buckling strength, torsion, and similar global strength analyses, in my opinion, would have been prudent.

After the *USCGC MATAGORDA* failure, the section modulus calculation of the midship section submitted by Bollinger was found to be in error and did not meet the American Bureau of Shipping (ABS) Guide for Building and Classing High-Speed Craft 1997. However, a peculiarity of small, lightweight ships is that buckling of shell plating in compression can more readily be a dominant mechanism of failure rather than cracking or tearing in tension, as is the case for larger ships. This was the case for the 123, and the side shell and deck buckled at a stress level well below the level that would cause cracking.

Modification One, comprising three straps welded on to each side, was performed after damage was observed on *USCGC MATAGORDA*, post conversion. This raised the section modulus enough to meet the American Bureau of Shipping (ABS) Guide for Building and Classing High-Speed Craft 1997 and to reduce the stress to an acceptable level. The straps also increased the allowable buckling load on the critical plates.

Modification Two was initiated when *USCGC NUNIVAK* subsequently suffered buckling damage at the aft end of the straps added in Modification One. This changed the end details of the straps, staggered the ends, increased the plating thickness in way of the ends and added additional internal stiffeners to better connect the new structure added during lengthening to the existing structure.

These structural modifications eliminated the basic deck and side shell problems, but other problems have since surfaced, most notably problems with reduction gear-to-shaft alignment, buckling of the engine girders, bottom longitudinals and transverse framing, cracks in the aluminum deck, and cracks near the main engine exhaust.

After the *USCGC MATAGORDA* damage, a private contractor, BMT Designers and Planners, Inc, was engaged to perform Finite Element Analyses of the 123-foot Patrol Boat structure. These analytic studies were able to almost exactly duplicate the damage seen. The modifications were also analyzed.

Following these studies, it was decided to perform full scale tests to check the validity of the modifications. Discussions with the Navy's Combatant Craft Division were re-opened, culminating in a meeting between myself and Combatant Craft Division representatives (Mr. Casamassina, Mr. Russell, and Mr. Whitford) at Little Creek, VA on July 8, 2005. Mr. Nappi, from Naval Sea Systems Command (NAVSEA, also participated in our discussion over the phone for a short duration. Based on their studies of the 179-foot Patrol Craft, Combatant Craft Division had suggested starting with an idea that the section modulus was inadequate, causing excessive stress, which in a broad sense, is correct. The 179-foot Patrol Craft problem, though similar in root cause (lengthening the vessel causing increased bending moment) had a different failure mechanism, cracking of the structure in the deck due to tension in hogging, so the initial speculations of Combatant Craft Division were based on this experience. However, the 123-foot Patrol Boat is buckling due to compression in sag, which creates differences in subtleties that Combatant Craft Division has not had the opportunity or funding to study or understand. Shortly afterwards, in response to a request by Combatant Craft Division, I invited Mr. Whitford to visit a damaged cutter at Savannah, GA.

Combatant Craft Division proposed an extensive test program and analysis that cost roughly five times more than a simpler, but comparable program proposed by the BMT Scientific Marine Services, Inc. Even at this point, funding for studying the 123-foot Patrol Boat was limited and I was unable to justify the higher cost. BMT Scientific Marine Services, Inc was also the contractor for testing the 179-foot Patrol Craft, so it was selected for the trials. An additional consideration was that BMT Designers and Planners, Inc had already performed numerous analytic studies of the 123-foot Patrol Boat and would therefore be well-suited for the phase of the contract relating the sea trials data to the analytic results, whereas Combatant Craft Division would have to repeat the process of setting up and validating a Finite Element Analysis model, since it uses different software. There was also concern that Combatant Craft Division would need considerable time and effort to get up to speed on the differences between the 179-foot Patrol Craft cracking and the 123-foot Patrol Boat buckling when BMT Designers and Planners, Inc. had already done this.

Subsequently, a variety of tests, analyses, and reviews have been performed including independent third party verifications and reviews. Assessment of these analyses indicates that the problems are due to some combination of shear, torsion, and "C-channeling" (structural instability of the upper side and deck edge) working together in a complicated manner. Vibration dynamics and transverse loading may also play a role. The mechanisms of failures: buckling of the side shell and deck, buckling of the engine girders, bottom longitudinals and transverse framing and the resultant problems with reduction gear to shaft alignment, are all interacting in a complex fashion, and even Finite Element Analysis is unable to accurately predict all of these complex interactions. I was directed to consult the original designer of the 110-foot Patrol Boat, VT Shipbuilding, and engaged them as a third party reviewer. I also formally and informally engaged many other experts on this project including experts on ship structure at the U.S. Naval Academy and at University of California, Berkley. Though all of these experts initially thought that this was a simple matter of inadequate section modulus, after extensive study all agreed with me that the problem is not so simple as just increasing section modulus. This is obviously an afterthought, since the very first modification increased the section modulus substantially but problems continue.

Nevertheless, the contractor was advised initially that this was potentially a complex problem, and that extensive study was required to do this safely. It is very important to note that there is as yet no fully quantitative analysis that unequivocally confirms the mechanisms of damage, or their relative importance, other than the initial buckling failure, especially as regards the shaft alignment and bottom internal structure. The argument for each individual mechanism and the relative role of each rests on a combination of circumstantial evidence and a process of elimination. After analyzing all additional information, the Coast Guard's Engineering Logistics Center has developed a solution that might address all of the possible mechanisms of damage; add a stiff beam in a closed tube to the upper edge of the deck. I believe this will address the major structural problems, but I cannot provide complete certainty that this will work, or that there are no other unanticipated problems. Unfortunately, this uncertainty is the result of doing such an unprecedented modification to a light weight, high speed craft.

I believe this shows that the Coast Guard has to have more direct responsibility for, and control of, future acquisitions, and that the Coast Guard has to rely more on the experience of existing, proven vessels, and the experienced designers of these specialized high speed craft. This had been the practice that produced the successful 87-foot Patrol Boat and the original 110-foot Island Class Patrol Boat, and is the strategy that Coast Guard is now following for the Replacement Patrol boat (FRC-B).

Thank you for the opportunity to testify before you today. I will be happy to answer any questions you may have.